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CORPS OF ENGINEERS, U. S. ARMY

THE ENTRENCHED VALLEY OF THE LOWER RED RIVER



TECHNICAL MEMORANDUM NO. 3-298

WATERWAYS EXPERIMENT STATION

VICKSBURG, MISSISSIPPI

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AUGUST 1949

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PREFACE

The geological investigation of the Lower Red River Valley was authorized by the President, Mississippi River Commission, in a letter to Dr. H. N. Fisk, consultant, dated 29 July 1947, and investigation of the southern portion of the Red River Alluvial Valley was initiated during the latter part of 1948. Due to higher priority work, the project was halted shortly after its inception until February 1949.

Field work, collection of logs of borings, and preparation of the maps and written material were accomplished by C. R. Kolb under the general supervision of W. J. Turnbull, Soils Division, Waterways Experiment Station. H. L. Evans and J. W. Cagle assisted in plotting borings and assimilating other information.

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THE ENTRENCHED VALLEY OF THE LOWER RED RIVER

PART I: INTRODUCTION

Purpose and Scope of the Investigation

1. A geological investigation of the Lower Red River Valley was undertaken to determine: (1) the sequence of events and history of the alluvial valley; (2) the configuration of the erosion surface developed on the Tertiary deposits and at present largely buried under Recent materials; (3) the nature, distribution, and origin of Recent alluvial deposits; and (4) the importance of these features with regard to engineering works. This report is concerned primarily with the first and second items and will be followed by a more detailed and comprehensive report on the entire project.

2. The studies reported herein cover that portion of the Lower Red River Valley which extends from the vicinity of Shreveport, Louisiana, to the junction of the Red and Old Rivers. The Tertiary stratigraphy of the valley is summarized with special emphasis on the type of sediments comprising the floor and walls of the entrenched valley, and a contour map showing the configuration of the entrenched valley of the Lower Red River is included. Since the course of the modern Red River is different from that of the entrenched valley south of Bunkie, Louisiana, it will be noted that the detailed maps and plates included in this report do not concern themselves with the area near the present mouth of the river. This portion of the modern Red River will be included in the more

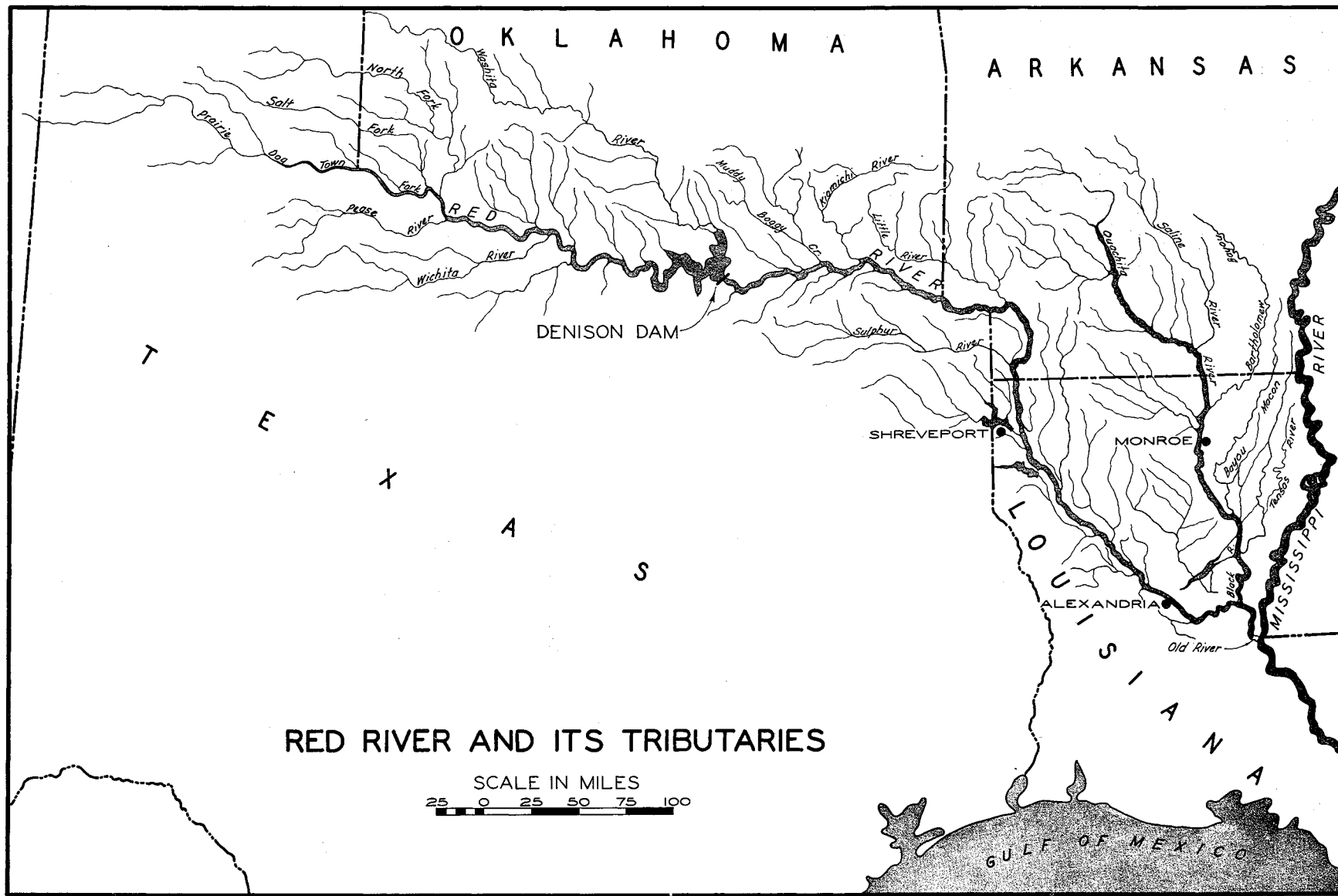
detailed report mentioned above.

Geography of the Red River Valley

3. The headwaters of the Red River are formed by intermittent streams which rise in the plains section of eastern New Mexico. Along the Texas-Oklahoma border these streams converge into a shallow main channel which is wide and indefinite, with the thread of current shifting from time to time with the infrequent rainfall of the region. Loose, sandy, easily eroded material forms the channel bed and banks. Farther east, along the eastern Oklahoma-Texas and Arkansas-Texas boundaries, the Red River flows in a clearly defined, but unstable, channel with a narrow floodplain. As it enters Louisiana the river turns southeastward and follows a diagonal course across the state. South of Alexandria, in the vicinity of the Avoyelles Hills, it turns generally eastward for 30 miles, then flows south for about half that distance and discharges into Old River near Simmesport, Louisiana, about 1,300 miles from its headwaters. The river drains approximately 66,600 square miles of land area. Its two major tributaries are the Washita River which enters the Red in Oklahoma, and the Black-Ouachita River system which joins the Red River east of Marksville, Louisiana, (see figure 1).

4. The Red River drains a portion of the arid and semi-arid Great Plains and Central Lowlands regions for more than half its course. It skirts the southern edge of the Ouachita Mountains and near the Oklahoma-Arkansas border enters the Gulf Coastal Plain. Suspended materials derived from red Pennsylvanian and Permian rocks of Oklahoma and Texas are considered the cause of the river's brick-red color. Highly

Figure 1



oxidized Tertiary outcrops of northern Louisiana may add to its vividness. The color of the soils which form the alluvial plain of the Red River is probably the most distinctive of any of the major streams of the Gulf Coastal Plain. The river is red, tilled fields are red, and the mud of swampy areas is red. Depending on the season, brick-red dust or red mud forms the beds of secondary roads in the alluvial valley. Agricultural soils maps of the parishes along Red River have long distinguished the alluvium on the basis of its color. The red color of the alluvium is even more striking in the extreme southern end of the valley where alluvium from the Red River and the Mississippi River intermingle. East of Marksville, Louisiana, where Red River sediments lie on top of Mississippi alluvium, the change from red to gray sedimentation at shallow depth in borings and along the banks of the Red during low water stages is most marked.

PART II: THE LOWER RED RIVER VALLEY

Description of Area Studied

5. Common usage arbitrarily limits the Lower Red River Valley to that portion of the valley below Denison Dam (see figure 1). For the purposes of this interim report, however, the designation Lower Red River Valley will be applied to only that part of the valley studied thus far which includes that portion from the northern boundary of Red River Parish immediately south of Shreveport, Louisiana, to Old River (see plate 1), a distance along the river of 270 miles. Larger riparian towns in this section include Coushatta, Campti, Natchitoches, Colfax, Boyce, Alexandria, and Marksville. The area under study approximates 1,500 square miles of floodplain, with agricultural lands limited only by poor drainage in low and swampy places. The present river course is either centrally located in the floodplain or flows close to the eastern valley wall. The maximum, average, and minimum discharges reported at Alexandria are approximately 210,000, 29,000, and 1,180 sec-ft, respectively. At its mouth the greatest known flood is estimated at 280,000 sec-ft, and minimum flow at 2,600 sec-ft (18).^{*} A tabulation for 1945 (16) lists a maximum discharge of 243,000 sec-ft at the junction of the Black and Red Rivers.

Shape of the Valley

6. Figure 2 includes an outline of the alluvial valley and a

^{*} Numbers in parentheses refer to sources of material cited in the bibliography which follows the text of this report.

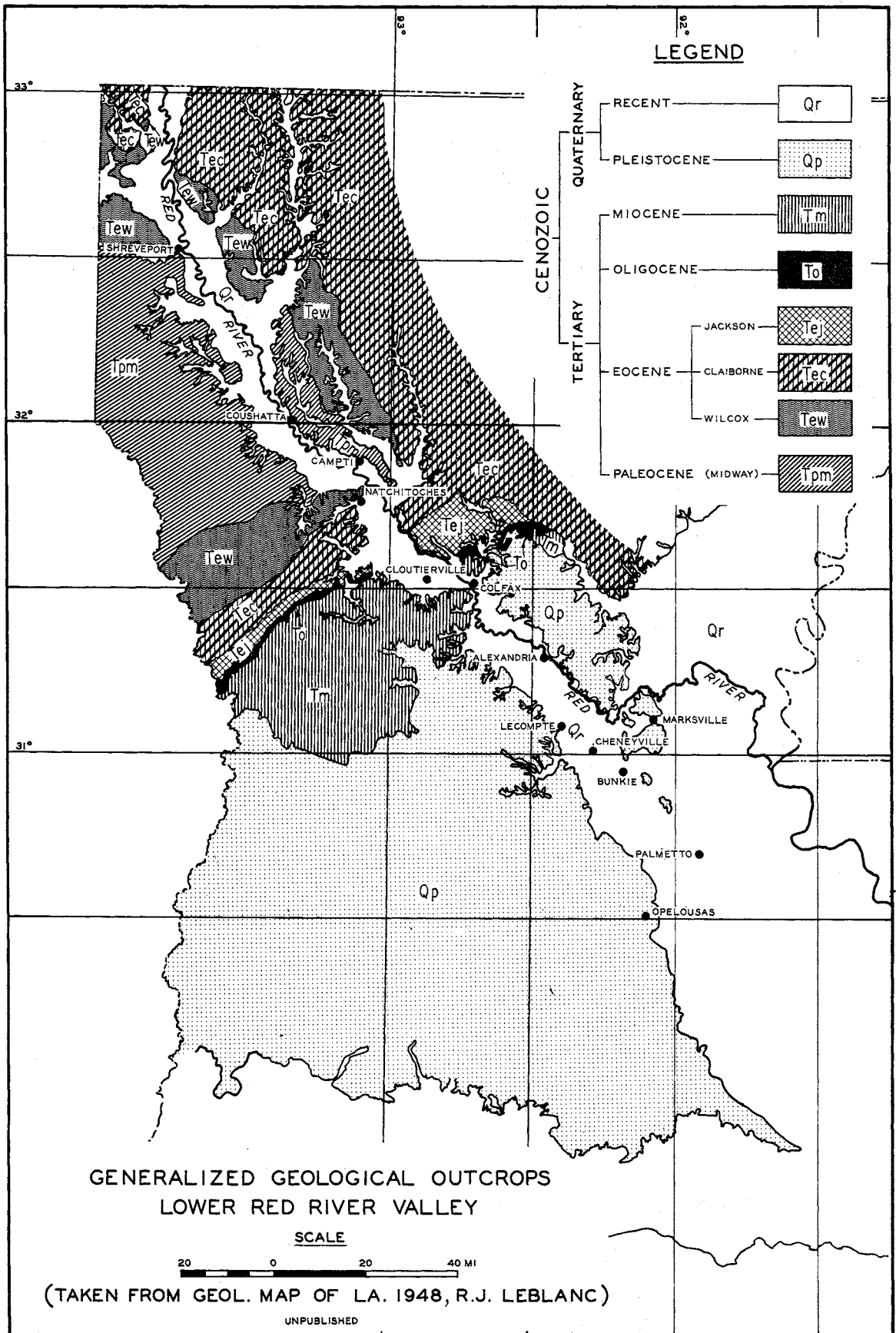


Figure 2

generalized map of the Pleistocene and Tertiary formations that border it. Recent alluvium fills the valley as well as the tributary valleys which enter it. In Louisiana the valley varies from 2-1/2 to 12 miles in width and forms a large irregular arc with its concave side facing the northeast. The essentially level alluvial plain is flanked on either side by a hill section which to the west forms the divide between the Sabine and Red Rivers. To the east is the highly dissected hill land separating the Red from the Ouachita-Black River system. These hill lands are composed of Tertiary sediments overlain by a discontinuous blanket of Pleistocene gravels. One series of sediments, the Catahoula sand and siltstones of lower Miocene age, forms a distinct high barrier which runs transversely to the direction of stream flow and crosses the alluvial valley in the vicinity of Colfax (see figure 2). Here, constriction of the valley is marked. This resistant ridge can be traced to the northeast and to the southwest as the Kisatchie Wold. A somewhat similar but less pronounced constriction occurs near Natchitoches, where sediments of Wilcox age have resisted the effects of fluvial erosion. The variety of Tertiary sediments which underlie the Recent alluvium of the valley and crop out along the valley walls will be discussed later. Those above the floodplain are masked almost everywhere by widespread gravel-bearing terrace deposits which also flank the alluvial valley and rise step-like above the present valley floor.

Structure

7. The dominant structure in the area is the Sabine Uplift, which affects a large portion of northwest Louisiana as well as the three

adjoining states. This roughly circular uplift, however, seems to have little effect on the present direction of stream flow for the Red River flows across its northeastern flank with no apparent deviation from course. Numerous minor faults and some distinct major faults are thought to cross and parallel the valley. The Red River fault system, which trends northwestward, is an example of the former; the Catahoula Lake Fault Zone which crosses the valley south of Alexandria, an example of the latter. (14) Definitely mapped faults, such as those in the Natchitoches area (32) are probably reflected in the alluvial valley. Deep seated faults have been mapped at Bull Bayou Oil Field (34) in northwest Louisiana (T 12N, R 11W, see plate 5) but these seem to have had no effect on the Recent sediments in the valley. Several minor structures, such as the domal uplifts of the Eola and Cheneyville Oil Fields in the southern end of the valley have also had little apparent effect on Red River alluviation.

Physiography

Floodplain relief

8. The alluvial valley, which at first appears to be a featureless plain, presents some variation in relief. The dominant topographic highs are the natural levees; the lows are the backswamp and minor drainage basins. In the northern end of the valley, near Coushatta, the variation in relief is about 10 ft. Southward, the difference in elevation between natural levee crests and backswamp lowlands reaches an extreme of 20 ft. Relief in alluvial valleys is most pronounced in a direction at right angles to the direction of stream flow, or more

exactly, to the direction of valley elongation. Transvalley profiles (plates 6-10) illustrate the irregularities commonly encountered along lines running transversely to valley direction. Since natural levees are not confined to the borders of the present stream, but occur along abandoned channels of the Red River or along minor alluviating streams which often occupy these abandoned channels, several crests and troughs may occur along one profile. Viewed on a large-scale plan map or an aerial photograph, the crests wind downvalley in sinuous curves, one on either side of the present Red River, or on either side of minor streams.

Natural levees

9. Natural levees are highest near the channel of the stream which deposits them and slope gradually away into the low-lying backswamp areas. Because these low areas are poorly drained, cultivated land ordinarily is confined to the natural levees. Viewed from the air or on an aerial photograph, the two are readily distinguishable; the backswamp as a densely-wooded, untilled area and the natural levees as broad strips of cultivated land that wind downvalley. The inhabitants of the valley, especially the older French-speaking inhabitants of the lower valley, have confined almost all their farming to the higher, well-drained lands along the natural levees. Modern roads sometimes follow natural levee crests of the Red River or of one of its abandoned courses, but will leave them if the resulting deviation from a straight line route is too great. However, older roads, especially those along the bayous of the southern valley, faithfully follow the crests of the levees. These roads are often paired, one on either side of the bayou. At intervals, an ancient

wooden bridge, built more for wagon than auto travel, spans the bayou. The roads turn with each arcuate bend of the old channel, doubling back on themselves to such an extent that the distance by road between two points is greatly increased. On the Bunkie quadrangle map, for instance, the air-line mileage from the village of Bubenzer, on the outskirts of Bunkie, to the village of Dubuisson is 15 miles. The distance measured by speedometer along the parish roads which flank Bayou Boeuf on either side is 37 miles. A continuous chain of houses and tilled acreage borders the roads. Property lines are based on bayou frontage and extend at right angles to the bayou, down the levee backslopes into the backswamp. Sections are long, narrow strips of land which only recently have acquired a legal backswamp border.

10. A curious phenomenon is that natural levees along the modern channel are somewhat lower than levees along some of the abandoned channels. An example is shown along transvalley profile B-B', plate 7. The natural levee crests, as measured from a recent topographic survey made in this section of the valley, are slightly higher along Cane River than along the Red. Since Cane River flows in a course abandoned by the Red only a little more than 100 years ago, it may be argued that the new channel has not had time to build natural levees to the height of those along the old channel. Added to the time factor is the impedance of artificial levees, which have prevented further natural levee sedimentation. Instances occur in the valley, however, where the Red River has been flowing in its present course since prehistoric time. Here too, despite lowering of the natural levees by erosional processes, their crests are often higher along abandoned courses than along the present

course. Fisk (13) attributes this to the steeper gradient which the Red acquired when it was diverted through Avoyelles Hills into the Mississippi Alluvial Valley. This, he suggests, not only resulted in smaller levees along the present Red, but cut a sub-Recent terrace in the vicinity of Colfax. Similar sub-Recent surfaces have been described upriver at Campti and Coushatta. (34)

Meander belts

11. Ordinarily minor streams, such as Bayou Robert and Bayou Boeuf, which occupy abandoned channels of the Red, faithfully depict the size of the stream which once occupied the course and deposited the natural levee. Examining the drainage system on plate 2, it is evident that the broad, widely-spaced curves followed by Bayou Jack and the lower portion of Bayou Rouge were once the channel of a stream of far different proportions than that which formerly occupied the narrower, more tightly meandering channel now followed by the Boeuf. Bayou Boeuf is identified as an abandoned channel of the Red (42), and Howe and Moresi (22) in tracing the Jack-Rouge system southward have recognized it as the ancient Teche course of the Mississippi. Meander belt widths, then, are related to the size of the stream which forms them. This basic difference in size of meander patterns has long been recognized. Jefferson (25) estimated that the width of meander belts is approximately 18 times the width of the parent channel. Russell (41) regards this principle as a most important step in deciphering floodplain history, but warns against applying it dogmatically. He cites as instances for caution: "the rule....must not be used for very limited distances along stream courses, as channel

widths vary too much from place to place. It will not cover immature meandering.....Nor will it cover cases of inhibited meandering, such as arise where streams impinge against valley walls."

12. Bayou Boeuf continues southward following its abandoned Red channel and eventually enters the Teche-Mississippi course in the vicinity of Opelousas. Russell (42) describes the resulting union as follows:

"Its alluvial deposit built a sharp crested pair of natural levees within the broad gray levees of Mississippi origin. Along Bayou Teche today these double crested levees are very conspicuous, accentuated as they are by shape, color, and soil contrasts. Houses and roads are built both along Mississippi and Red River crests. Ponds and minor drainage channels develop between, forming one of the most characteristic features of landscapes along one of Louisiana's best known and earliest settled bayous."

Drainage

13. Drainage in the Red River alluvial valley has long been a problem, but efforts during the past 50 years have aided considerably in reclaiming land by draining, in preventing the frequent flooding which resulted in backwater accumulation, and in clearing the Red River's channel so that it can carry the floodwaters which flow through it yearly. Natural levees, while acting as barriers for normal flood stages, also act as barriers to drainage water from the lowland backswamps which border the river. It can be seen from any large-scale map that streams in the floodplain are not ordinarily tributary to the main channel. In most instances, as has been noted, they are relics of former master stream occupation. Crevassing of this former channel and diversion of

the river to a neighboring lowland leave the former channel without its normal flow of water. The process of natural levee building along the new channel quickly raises a barrier between the former junction of the old channel with the new. Cane River Lake, which was a course of the Red River in historic times, is an excellent example of this type of abandonment (see plate 4).

Marginal lakes.

14. Lakes are prominent features along the borders of the alluvial valley. Black Lake and Lake Iatt (plate 1) are examples of these features. Various origins have been attributed to these lakes. The great floating log raft, which extended from Natchitoches more than 100 miles upstream and blocked river traffic until the close of the 19th century, has been credited with causing them. Several writers (45, 26) have pointed out that many of the lakes have drained entirely, or have at least experienced a drop in water level, since the removal of the raft. Others believe that the marginal lakes are due to an induced difference in elevation between the Red River floodplain and the floodplains of its tributary streams. Lateral shifting of the river to an area close to its valley walls, it is argued, would result in the building of a natural levee by the master stream which would act as a dam, and pond the waters of the tributary streams. In defense of this argument analogous marginal lakes along the Mississippi are pointed to as having an identical origin without benefit of rafting (13). Murray (34) summarizes the results of raft removal as follows:

"The most important effect of the raft removal was the restriction of the Red River waters to a single channel. This caused

the disappearance of diverted waters from the backswamp areas, and the temporary higher base level of these areas was destroyed. In consequence, the lake areas drained; and the streams flowing through these basins locally began the task of downcutting through the alluvium that had been deposited in them. This downcutting was restricted to the lower tributary valleys where rapid sedimentation had occurred. In other places, the lengthening of stream courses and decreased gradients associated with the draining of lakes caused alluviation. The deposits of alluvium filling the lower ends of the smaller tributary streams of this area attest to the activity of these processes."

Recent Changes Near Mouth of Red River

15. In comparatively recent times the river has changed its course south of Alexandria, so that now it flows eastward through the Avoyelles Hills, follows a tortuous course partially along an abandoned channel of the Mississippi and then flows south again to its junction with Old River. Old River, a 6-1/2-mile long connecting link between the Mississippi River and the Red-Atchafalaya River system, carries some of the waters of the Red to the Mississippi during low water stages of the latter. During normal and high-water stages, however, it acts as a distributary of the Mississippi and the entire discharge of the Red and a part of the discharge of the Mississippi empty directly into the Atchafalaya. The Atchafalaya, formerly thought of as an old channel of the Red, is now generally conceded to have been a minor stream which drained a basin-like area between two natural levee systems. It was only through crevassing of the Mississippi that it has acquired its present considerable flow.

Entrenched Course Near Mouth of Red River

16. Abandoned channels of the Red River such as Bayou Boeuf or

Bayou Rouge (plate 2), more faithfully mark the direction of the entrenched valley than does the present course of the river. Studies made by Fisk (14) and the results of the investigation reported herein indicate a confluence of the Red and Mississippi River trenches near Palmetto. Islands of Pleistocene terrace deposits (see plate 2) which extend south from the Avoyelles Hills as the Evergreen Hills and Gum Ridge mark the eastern wall of the entrenched valley. The western valley wall is a well-defined scarp which extends southward toward Opelousas (shown on figure 2), where it merges with the wall of an entrenched Mississippi river course.

PART III: STRATIGRAPHY

17. The character, age, and sequence of the rocks bordering the Red River floodplain from northern Desoto-Red River Parish boundaries southeastward through Rapides and Avoyelles Parishes have been investigated in some detail during the past two decades, principally under the auspices of the Louisiana State Geological Survey (see table 1). Isolated outcrops forming an almost complete sequence of Tertiary sediments can be found exposed along or near the valley walls. If stacked stratum upon stratum, these sediments would be more than a mile in thickness. The strata are tilted toward the south and east and dip in that direction from 50 to 75 ft per mile. The Sabine Uplift has complicated this normal dip and in the area southeast of Shreveport has exposed some of the oldest sediments in Louisiana. Tertiary sediments of Paleocene and Eocene age crop out in a roughly concentric pattern around this upwarped area (see figure 2).

18. In almost every instance the Tertiary materials are of a more indurated and firmer nature than the Pleistocene sands, silts and gravels which blanket the highlands on either side of the alluvial plain and the Recent loose sediments which form the bulk of the material filling the valley. This comparatively compact mass of sediments is exposed in the highlands and along the valley wall at intervals, but except for a few isolated instances, is buried beneath a cover of alluvium in the Red River Valley.

19. Sources of information for mapping the various stratigraphic units along the Lower Red River Valley were taken from published and

**TABLE I - STRATIGRAPHIC SECTION
LOWER RED RIVER VALLEY**

ERA	SYSTEM	SERIES	GROUP	FORMATION	MEMBER	LITHOLOGY
CENOZOIC	QUATERNARY	RECENT		Alluvium		Fine-grained topstratum grading downward into sands and gravels.
		PLEISTOCENE		Prairie		Clays and silts grading downward into sands and gravels.
				Montgomery		
				Bentley		
				Williana		
	TERTIARY	MIOCENE	GRAND GULF	Fleming	Blounts Creek	Fluviatile silts with local channel sand lentils.
					Castor Creek	Brackish-water calcareous clays and non-calcareous silts.
					Williamson Creek	Fluviatile silts and channel sand lentils.
					Dough Hills	Brackish-water calcareous clays and siliceous silts with local pyroclastic lentils.
					Carnahan Bayou	Fluviatile silts and channel sands with local brackish-water calcareous clay lentils.
					Lena	Brackish-water calcareous clays with siliceous silts and local pyroclastic lentils.
				Catahoula	Upper (sandy member)	Heterogeneous mixture of lenticular bodies of loosely compacted coarse sands, finely-bedded silty clays and organic silts.
					Tuffaceous Siltstone	Massive, blocky, tuffaceous siltstone, purple in color, containing palm fronds and stumps.
		OLIGOCENE	VICKSBURG	(Formation distinctions apparent in Mississippi cannot be located in central Louisiana)	Upper	Non-marine micaceous sandy clays with lenticular bodies of rounded medium to coarse sands interfingering with fossiliferous brackish-water beds containing marine lentils and glauconitic, lignitic shales.
					Lower	Gypsiferous khaki-colored, massive clays and a few thin beds of only slightly indurated fine-grained angular sand.
		EOCENE	JACKSON	Danville Landing		Khaki-colored interbedded sands and clays containing fossiliferous concretions.
				Yazoo Clay	Verda	Series of sparingly fossiliferous, brackish-water lignitic clays and interbedded silty sands with intercalated lenticular marine sandstones, fresh water leafbearing silts and marine clays.
					Union Church (Trans. phase)	Alternating thin beds of sandy silts and clays containing concretions and fossiliferous nodules cemented by limonite.
					Tullos	Calcareous clays, deep blue-gray color in fresh cuts but weathering to a drab, yellow or light gray, eventually breaking down into black soil.
				Moody's Branch Marl		Coarse-grained glauconitic marl with scattered limestone concretions. Marl consists of very fossiliferous glauconitic sands transitional with the lower lignitic silty clays of the Cockfield and the overlying Yazoo clays.
			CLAIBORNE	Cockfield		Lignitic silts and plant-bearing lignitic shales occur most abundantly. Lignitic sands occur also but are neither as extensive nor as well developed as the silts and shales.
				Cook Mountain		Fossiliferous calcareous shales, and glauconitic lignitic shales and marls.
				Sparta		Non-marine sands and sandy shale, lignites and lignitic shales, massive sands with pellets and stringers of clay.
				Cane River		Fossiliferous, sandy, highly glauconitic marl and chocolate brown calcareous shales.
			WILCOX	Carrizo		White to brown, very fine-grained, massive to crossbedded sand with abundant shale interbeds, partings and inclusions.
				Sabinetown	Upper (shale)	Silty, laminated, lignitic shale with glauconitic crossbedded fine-grained sand.
					Lower (Pearson glauconite)	Fossiliferous, locally calcareous and indurated glauconitic sand with shale and clay interbeds and concretionary siderite.
				Pendleton	High Bluff	Basal, glauconitic fossiliferous sand overlain by silts and sands containing calcareous concretionary boulders.
					Slaughter Creek	Fossiliferous, glauconitic sands with pipe-like limonite nodules and fossiliferous clays with glauconitic sand lentils.
					Bayou Lenann	Glauconitic fossiliferous sands grading upward into lignitic silts and sands with thin seams of lignite.
				Marthaville		Calcareous silts and clays, lignitic shales and sand, locally fossiliferous.
		PALEOCENE	MIDWAY	Hall Summit	Bistineau	Calcareous silts and shales.
					Grand Bayou	Carbonaceous and lignitic silts and clays.
					Loggy Bayou	Massive to broken sands with subordinate amounts of sandy shale and clay-ball conglomerates.
				Logansport	Lime Hill	Calcareous silts and shales.
					Cow Bayou	Lignitic and carbonaceous shales.
				Naborton	Dolet Hills	Massive sands and sands interbedded with shale.
						Calcareous silts and shales.

unpublished geological maps. The following description of the sediments underlying the entrenched valley of the Red River has been summarized from excellent and detailed accounts contained in numerous publications and a limited amount of unpublished material (see bibliography), supplemented by observations in the field.

20. From a foundation standpoint, Tertiary sediments in the Lower Red River Valley can be divided into four groups:

- a. The Midway-Wilcox sequence: a predominantly silty, lignitic, or calcareous group of sediments with minor amounts of clay and locally indurated sands.
- b. The Claiborne group: an essentially sandy unit with local clayey and silty units.
- c. The Jackson and Vicksburg groups: fat, firm, chocolate-colored clays with minor sands.
- d. The Miocene group: tough, erosion-resistant sands and siltstones near the base, with increasing amounts of clays and silty clays toward the top of the section. In the extreme southern end of the valley, silts, silty sands and clays of possible Pliocene age occur beneath the alluvium.

21. Quaternary sedimentation was a recurring cycle characterized by gravels grading upward into sand, silt, and clay. This is thought to have occurred four times during the Pleistocene, each sequence now being preserved as a terrace remnant. The latest similar cycle comprises the Recent sediments which fill the entrenched valley of the Red River.

Midway-Wilcox Group

22. The oldest sediments underlying the Recent alluvium of the Red River are the Midway and Wilcox silts, sands, and clays. Murray (36) has pointed out a cyclic pattern of deposition in the heterogeneous

complex of deltaic sedimentation which characterizes these beds in western Louisiana. The cyclic pattern on which he bases the separation of formations is composed of a massive to broken sand unit at the base of the pattern, followed by lignitic and carbonaceous shales, and finally calcareous silts and shales which usually contain fossils. Using these criteria, the following distinctions are made progressing downvalley and up the stratigraphic section.

Midway group

Naborton formation:

(Considered as the calcareous silt and shale member which marks the top of the cyclic series.)

Logansport formation:

Dolet Hills member (massive to broken sand)

Cow Bayou member (lignitic and carbonaceous shales)

Lime Hill member (calcareous silts and shales)

Hall Summit formation:

Loggy Bayou member (sand)

Grand Bayou member (lignitic silts and clays)

Bistineau member (calcareous silts and clays)

Wilcox group

Marthaville formation:

(As defined by Murray (34) this formation also contains a basal sand, a middle lignitic clay and an upper calcareous silt and clay. Not divided into members.)

Wilcox undifferentiated:

This thick section of sediments, mapped as undifferentiated Wilcox on plates 4 and 5, is divided into three formations, (Pendleton, Sabinetown, and Carrizo) which have in turn been divided into members. Most of the type localities for both the formations and their respective members are on or near the Sabine River. They have been traced eastward, however, and generalized outcrop maps have been published (36) (28) projecting the formations beneath the Red River Valley. The formations are the usual complex of lignitic, calcareous and fossiliferous silts, sands, and clays. Descriptions of the formations included in the undifferentiated

Wilcox follow.

Pendleton formation: The basal beds, the Pendleton silts, sands and clays, have been divided by Wasem and Wilbert (46) into the Bayou Lenam, Slaughter Creek and High Bluff members. To the writer's knowledge, these members have not been distinguished along the Red River Valley in Natchitoches Parish.

Sabinetown formation: This formation is excellently exposed in the high bluff at Grand Ecore immediately east of Natchitoches. Justin Rukas divided this formation into a lower glauconitic member, the Pearson glauconite, and an upper shale member. (46) (36) The lower member is described as a typically fine-grained green sand or glauconitic sand containing considerable concretionary ironstone. The upper shale member consists of lignitic silty shale with subordinate amounts of carbonaceous clay, silt, and sand.

Carrizo formation: Murray (34) describes this formation as massive to broken, fine-grained sand with lesser amounts of sandy shale and clay. The sands are typically nonglauconitic and nonarkosic; a fact which serves to differentiate them from some of the other Midway-Wilcox sands. Typical Carrizo sand outcrops occur in northern Natchitoches Parish.

23. The formations of the Midway-Wilcox groups appear to be generally tight and comparatively erosion-resistant. The valley cut through these sediments is narrow and the highland areas on either side are pronounced. If any of the formations mapped on plates 4 and 5 can be said to be more resistant than the others, the group classified as undifferentiated Wilcox would be the most proper selection. This group forms the high neck of land which constricts the valley north and east of Natchitoches to approximately 3-1/2 miles. Estimated thicknesses of formations outcropping along the valley walls are:

Naborton formation	150 ft
Logansport formation	400 ft
Hall Summit formation	200 ft
Marthaville formation	100 ft
Wilcox Undifferentiated	500 ft

Claiborne Group

24. This group of sediments consists of a moderately resistant mass of predominantly sandy material which forms the floor of the valley immediately southeast of Natchitoches. The Claiborne is readily divisible into the Cane River, Sparta, Cook Mountain, and Cockfield formations. Boundaries of these formations shown on plate 4 were taken from an unpublished map of Rukas' (38) and a published map by Huner (24).

Cane River formation:

This formation is excellently exposed at its type locality along Cane River, an abandoned channel of the Red River, now the waterfront for the city of Natchitoches. Shearer (44) divided the Cane River formation into a clay above and a marl below. He describes the members as follows:

"The top of the upper member is sandy shale, which grades downward into smooth, plastic, slightly calcareous clay-shale. This material is characterized by its dark, chocolate-brown color, generally specked and streaked with light green. It is all marine, and foraminifera are plentiful.

"The lower member consists of fossiliferous, sandy, highly glauconitic marl or soft limestone. It is commonly logged as 'salt and pepper sand' because of the appearance of white limestone with grains of dark glauconite."

Sparta formation:

The bulk of this formation is described as nonmarine massive sands and sandy shales. The upper portion contains lignites and lignitic shales. This formation weathers readily on surface outcrops into a red brown sandy soil.

Cook Mountain formation:

This formation has been divided (24) (10) into the following members.

Dodson member: basal, fossiliferous glauconitic, clayey sands.

Milams member: calcareous glauconitic shales, lignitic shales and marl.

Saline Bayou member: fossiliferous calcareous shales with abundant limonite nodules. This member is well exposed at St. Maurice, just north of Montgomery.

Little Natches member: fossiliferous sands and sandy shales.

Cockfield formation:

Composed of lignitic silts, plant-bearing lignitic shales, and massive, light-colored sands with thin-bedded sandy clays. No fauna has been reported.

Approximate thicknesses of the formations in this group are:

Cane River formation	250 ft
Sparta formation	450 ft
Cook Mountain formation	200 ft
Cockfield formation	400 ft

Jackson and Vicksburg Groups

25. These two groups, composed principally of fat clays, form a narrow outcrop belt in the highlands along the Red River Valley extending from near Montgomery southward to the vicinity of Colfax. They are more easily eroded than the underlying Claiborne and especially the overlying Miocene sands. The valley walls (see plates 4 and 7) widen perceptibly where these sediments form the floor of the valley.

Jackson group:

Moody's Branch marl formation: This formation is excellently exposed at Montgomery Landing. It is composed of fine- to coarse-grained, sandy, glauconitic, fossiliferous marl, varying from 10 to 15 ft in thickness.

Yazoo Clay formation: Divided into the Tullos member, the Union Church transition phase and the Verda member. The Tullos is a deep blue-gray, fat clay. The Union Church transition phase is described as alternating thin beds of sandy silts and clays, with light-brown concretions in the upper part. The Verda member is composed of brackish-water lignitic clays with interfingering sand and sandstones. (11)

Danville Landing formation: A group of khaki-colored clays with the interfingering silt and sand units containing fossiliferous concretions. (1)

Vicksburg group:

This group has been divided into a lower, gypsiferous, khaki-colored, massive clay, and an upper nonmarine, micaceous

sandy clay with some well-rounded, medium- to coarse-grained sands. (11)

26. The combined thickness of these two groups is estimated at about 650 ft; the Jackson approximating 450 ft in thickness, and the Vicksburg 200 ft in thickness.

Miocene Group

27. This group, viewed as a unit, is comprised of interfingering silts, silty sand and clay units, with locally firmly indurated sand and silt bodies which near the base of the section are the most durable of the Tertiary sediments occurring along the Lower Red River Valley. The topographic high which crosses the valley near Colfax and narrows it to only slightly over two miles owes its existence to the tough basal sand and siltstones of this group. Tough siltstones of this group once formed the bed of the river slightly north of the city of Alexandria. A series of rapids at this point, resulting from a seven-foot fall in two miles, obstructed the entire width of the river (45). The early "Rapides Settlement" for which Rapides Parish was later named was built in the vicinity of these rapids. Subsequent river scour has reduced these resistant beds and opened this stretch of the river to navigation. Surface outcrops have been mapped as far south as central Rapides Parish, (13) (11) (38) where the Miocene is completely masked by Pleistocene terrace deposits or Recent alluvium. A considerable thickness of undifferentiated upper Miocene, and possible Pliocene beds, forms the floor of the entrenched Red River Valley south of Bunkie. The Miocene group, as exposed in the highlands along the valley walls, is divided into two formations.

Catahoula formation:

This formation consists of two members, a lower tuffaceous siltstone member and an upper sandy member (13). The lower member is described as a massive, blocky, tuffaceous siltstone. The siltstone occurs in thick extensive beds, locally interbedded with thin-bedded pure tuff deposits which vary in thickness from 1 to 5 ft. The upper sandy member consists of a heterogeneous mixture of lenticular bodies of loosely compacted coarse sands, finely-bedded silty clays, and leaf-bearing silts. The coarse sands, more common near the base, are locally quartzitic.

Fleming formation:

Like the Catahoula, this formation consists of silts and sandy silts, with interfingering units of silty sands and clays. Fisk (13) has divided the formation into six members on the basis of fluviatile and brackish-water facies.

- Lena member (brackish-water)
- Carnahan Bayou member (fluviatile)
- Dough Hills member (brackish-water)
- Williamson Creek member (fluviatile)
- Castor Creek member (brackish-water)
- Blounts Creek member (fluviatile)

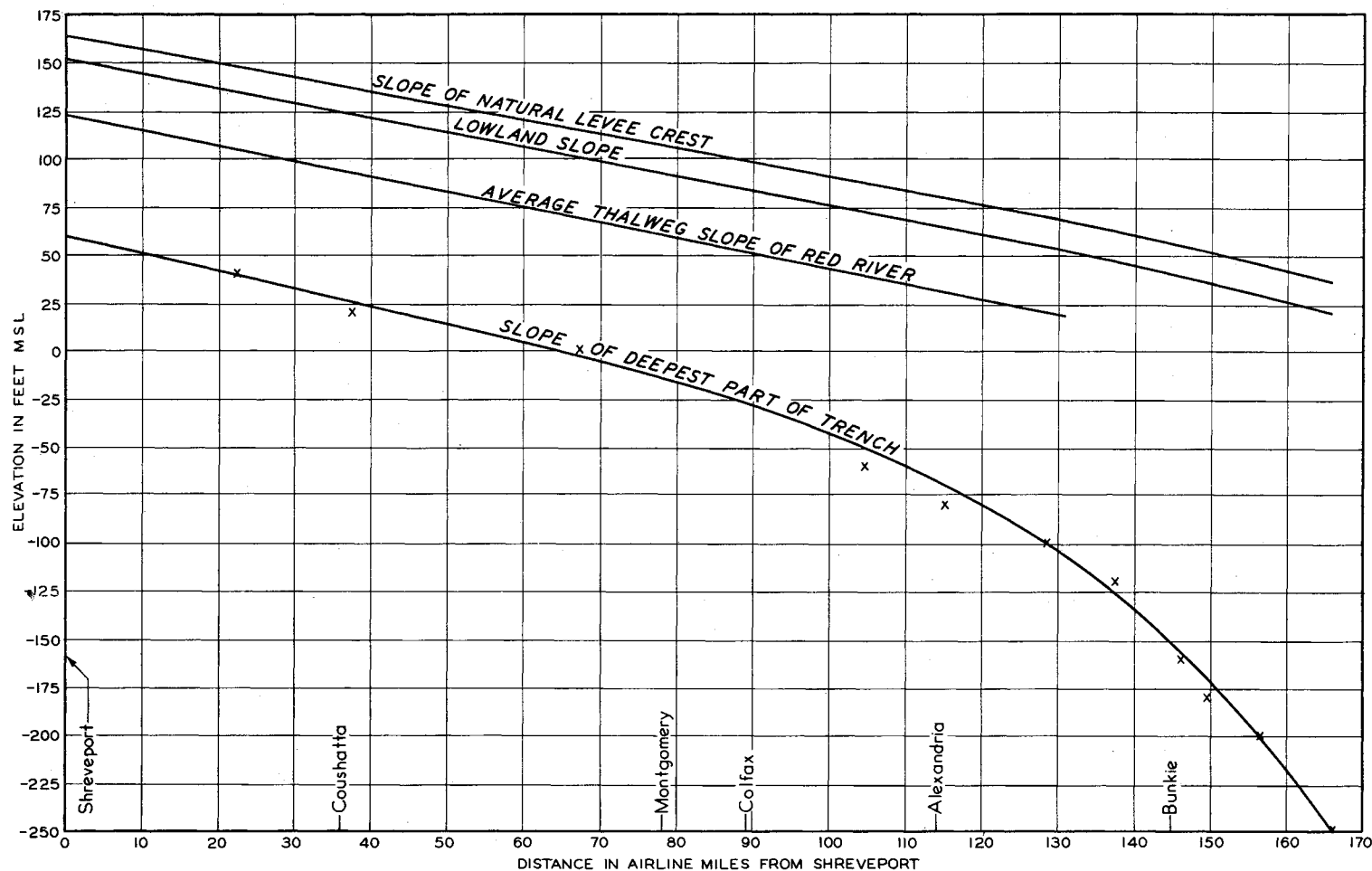
28. The thicknesses of these formations have been roughly estimated as 500 ft for the Catahoula and 1,500 ft as represented by the Fleming or that part of the upper Miocene which crops out at the surface.

PART IV: VALLEY ENTRENCHMENT

29. Numerous borings indicate that the depth of alluvium beneath the Red River Valley is far greater than the maximum depth of river scour. This has been known for a number of years concerning the major aggrading rivers of the Gulf Coastal Plain. The trench beneath the Mississippi has been contoured (14) and depths of alluvium far in excess of those encountered in its tributary valleys have been found. Figure 3 shows the average slope of the entrenched valley of the Red River, which, in the area studied, is everywhere below the thalweg of the modern river and is decidedly below river scour in the southern end of the valley.

30. Under normal conditions aggrading rivers are thought to actively widen their valleys and build up their floodplains by shifting laterally across alluvial valleys as meander loops are developed and abandoned. That the Red River does actively widen its valley by corrasive action along the valley walls and has done so in the past is evident. Transvalley profiles show a steep contact between the Recent and Tertiary sediments at the valley wall. Though there are relatively few places in the present course of the river where it impinges against its valley wall, the entire present width of the Red River Valley could easily be postulated as the result of such lateral corrasion, but the latter could hardly account for the depth of its entrenched valley. In the area under observation, even near the northern boundaries of Red River Parish where the alluvial cover is thinnest, present depth of river scour is only about one-half the depth of the alluvium. Ancient channels, easily definable on the aggradational surface, as well as

Figure 3



ENTRENCHED VALLEY OF RED RIVER
AVERAGE SLOPES

present channels, often scoured to bedrock but in the large majority of cases they cut into and transported only their own alluvium.

31. The source of this alluvial cover and the cause for the anomalous depth of the entrenched valley are satisfactorily explained by considering the effects of glaciation. Few people doubt the existence of the Ice age when mile-thick sheets of ice covered large portions of the continents, but, as far back as 1842, glacialists were going farther. Charles Maclaren (29) deduced that a sheet of ice of such large dimensions and representing such an enormous amount of water would necessarily lower the level of the sea by hundreds of feet. Daly (8) after the turn of the century, in calculating the amount of ice coverage and applying various corrective factors, reached a figure of about 400 ft for the maximum lowering of sea level during glacial times. In a broad, gently-sloping region, with comparatively little relief, such as the Gulf Coastal Plain, a lowering of sea level by 400 ft would greatly increase the gradient of the streams and result in rapid downcutting and the excavation of deep V-shaped valleys in the Tertiary sediments.

32. The amount of water flowing down the entrenched valleys during glacial times when sea level was falling and during interglacial times when sea level began to rise has been variously estimated. Flint (15) deduces that comparatively large volumes of meltwater were discharged in the valleys that led away from the ice sheets. He states, "The greatest proglacial (area in front of a glacier) drainage system in North America was the Mississippi-Missouri-Ohio system, which drew its discharge from a sector of the ice sheet nearly 2,000 miles long. Even at the times when the ice sheet was at its maximum extent the combined

discharge of these rivers probably was greater than it is today because precipitation must have been greater. During the times of most rapid glacier shrinkage, when stored-up frozen precipitation was being melted and discharged much faster than it was being replaced, the discharge was surely very much greater than at present." (15)

33. Many think that the present is actually part of the interglacial stage and that the ice sheets are still in the process of deterioration. Observations made over a number of years on the Antarctic ice sheet indicate a slow shrinking. Sea level has been rising at the rate of $1/4$ in. in a century for the past few hundred years. Were all the ice on land surfaces of today to melt, it is estimated that the rise in sea level would be sufficient to inundate the Gulf Coastal Plain as far north as Greenville, Mississippi, or cover the land surface to a depth of 180 ft.

34. Daly (7) in a classic paper makes this observation: "Geology has been developed by men living in the middle latitudes of the Northern Hemisphere. To those leaders of thought the Glacial period is of the past. For a geologically-minded penguin of Antarctica the Glacial period is here and now. The truly objective philosopher must agree with the penguin: the earth as a whole is something like halfway through the Glacial period."

35. Whether the present represents the culmination, or merely the latest retreat of a series of ice sheets is a question for the unpredictable future. The stratigraphic boundaries between sediments resulting from these various glacial advances and retreats, however, especially the boundary between present alluviation and the strata

underlying it, need an inclusive and workable definition. The time and stratigraphic limits of the Pleistocene and the Recent are still a matter for considerable debate. These two units, comprising a relatively short span of geologic time are nevertheless of considerable extent and importance in the Gulf Coastal Plain. Russell (42) in a recent publication has revived a suggestion made by Reade (37) in 1872 who defined the Recent as the time during which the latest major rise in sea level occurred. In areas such as the Gulf Coastal Plain, where degrading streams during waning sea level are the chief molders of topography and aggrading streams during glacial stages cover the resulting erosion surface with a mantle of alluvium, this definition is of considerable value. The time period involved is estimated at between 20,000 and 30,000 years. The contact between Pleistocene and Recent deposits, which becomes progressively younger upstream, represents that time in the history of valley-filling when streams ceased to erode and began to deposit materials. It is marked not only by an erosion surface, but also by the sequence of alluviation which is invariably from coarse to fine. Some of the Coastal Plain rivers, such as the Escambia or the Alabama, could not alluviate their valleys rapidly enough to match the rise in sea level and were consequently drowned by embayments of the sea. The Mississippi had more than sufficient bed load to alluviate its valley and hold back the encroaching sea. It is estimated that in Recent times the sea never came farther inland than the vicinity of Baton Rouge, Louisiana. (40)

36. When sea level began its most recent rise the area near the mouth of the entrenched Mississippi was the first to be affected.

As sea level rose, stream gradients lessened. The river, no longer able to carry its heavy load to the sea, began to deposit its coarsest materials. A wave of gravel-bearing alluvium spread upvalley. Alluviation along the tributary stream valleys began in a similar fashion. A thick, graveliferous fan was built at the mouth of the Red River. This fan spread upvalley in a gradually thinning wedge, which ranges from over 100 ft in thickness near Bunkie, to 10 ft or less near Natchitoches. Continued rise of the sea lowered the stream gradient and caused the Red to deposit smaller and smaller grain sizes, so that the sequence of gravels to sandy silts and silts in any one boring is always preserved.

37. Approximately 150 billion cubic yards of alluvium fill the entrenched valley of the Lower Red River from the northern boundary of Red River Parish to its junction with the Mississippi River trench near Palmetto. This figure does not take into consideration the volume of alluvial material in the numerous tributary valleys that breach the valley walls and drain the highland areas. The surface of the alluvial fill slopes gently upvalley. It rises from 30 ft msl at its lower end to 150 ft at the northern end of the area under study, or a rise of 120 ft in approximately 150 miles of airline distance (see figure 3). The alluvium completely masks the erosional surface which lies below it. Only where the ancient surface rises above the present level of alluvium is there any indication of the former rugged topography which the alluvium buries. Couchanda Hill on transvalley profile A-A' (plate 6) and such Pleistocene "Islands" as Gum Ridge on plate 2, are examples of topographic highs on the old erosional surface which have been surrounded by the wave of Recent alluvium which has filled the valley.

38. Since the limits of Recent deposition and the limits of the alluvial valley are the same, the general outlines of the valley can readily be seen on the geological map, figure 2. More detailed limits are shown on plates 2, 3, 4, and 5 together with contours showing the configuration of the pre-Recent surface which lies beneath the alluvium. Transvalley profiles, plates 6, 7, 8, 9, and 10, show the shape of the valley generally at right angles to valley direction.

Transvalley Profiles

39. The shape of the entrenched valley along transvalley profiles is a flattened V-shape in the northern end of the area under study, developing into a steep-sided valley with a flat or gently sloping bottom in the southern end. It has been suggested that an entrenched valley such as that of the Red could be described as bathtub-shaped.* The analogy has some value. It pictures a valley with steep-sided walls and a more or less flattened floor. Add to this general shape a minor V-shaped trench somewhere along the bottom of the tub marking the position of the entrenched channel, slope the floor of the tub gently toward this trench from either side, and the picture is complete.

40. Not only the transvalley profiles, but closely spaced contours near the highlands on plates 2, 3, 4, and 5, indicate the steepness of the valley walls. At the extreme northern end of the valley the

* Entrenched valleys such as that of the Red or the Mississippi could more aptly be termed U-shaped than V-shaped, but since a U-shape has long been associated with a valley caused by glacial scour, in contrast to the V-shaped valley caused by running water, the term U-shaped will be avoided in this discussion.

walls extend to a depth only a little greater than average depth of scour of the present channel. Farther downvalley (transvalley profile A-A', plate 6), however, the depth along the valley walls increases to somewhat below average depth of river scour. Still farther south, along the Cloutierville line of borings (transvalley profile B-B', plate 7), the flattened floor of the valley is distinctly evident. On transvalley profile C-C', plate 8, near the southern end of the valley the shelf is wider and even more pronounced, and has been cut at a depth of at least 100 ft below the deepest portions of the modern Red River. The existence of such a shelf-like feature far below the depth of modern scour indicates the activity of an agency such as lateral corrasion when sea level had not yet reached its present stand.

Longitudinal Profile

41. In longitudinal profile the entrenched valley has an average slope that is convex upward (see figure 3). This ordinarily indicates that erosion has not acted on a stream for sufficient time for a normal profile to be assumed. The normal profile for streams in most regions, and especially in regions of low relief, is convex downward with the gradient of the stream increasing toward its source. The formidable barrier of the Catahoula sandstone, which outcrops on either side of the valley and underlies the Recent alluvium in the vicinity of Colfax, probably greatly influenced the shape of the stream profile. It not only narrowed the valley to less than three miles but caused waters to be impounded behind the barrier. Borings along the B-B' profile near Cloutierville encountered typical Jackson clays at their base which had

been reworked and imbedded with Pleistocene gravels. This indicates the probability of a lake in the arcuate segment which forms the valley immediately north of Colfax -- a lake which may have caused the only alluviation taking place in the valley during glacial times. Whether the water-gap through which the entrenched waters of the Red River flowed was a natural break through some less indurated portion of the Catahoula sandstone, or has some structural implication connected with the Red River Fault System, is unknown.

42. The slope of the profile south of Colfax steepens until in the vicinity of and south of Bunkie the drop of the entrenched valley into the Mississippi entrenched valley is at the rate of 5 to 6 ft per mile. The thalweg of the modern river drops at a rate of 0.5 ft per mile.

Entrenched Valley Contours

43. The valley walls, as has been noted, are steep. The trans-valley profiles (plates 6-10) illustrate this feature and wherever information was available contours near the valley walls are closely spaced (plates 2-5). Where detailed information was not available the contours are spaced farther apart and the steepness of the valley walls is probably incorrectly de-emphasized. Topographic maps of the area show a highly dissected hill land on either side of the valley. Similar topographic irregularities in the entrenched valley are to be expected. Since limited borings make such detailed accuracy impossible, the deep valleys and sharp-crested divides of the highland are extended as comparatively undissected valleys and divides beneath the Recent

alluvium of the floodplain. The location of these subsurface valleys and divides was sometimes indicated by an isolated boring; however, where borings were lacking, streams tributary to the entrenched Red River were considered as having followed the trend of the tributary valleys which now enter the alluvial plain. In spite of these limits to the accuracy of the contours, it is felt that nowhere will the error exceed more than the contour interval.

The Entrenched Channel

44. The entrenched Red River, as reconstructed from the contour maps, flowed in an irregular channel that shifted from the right to the left wall of the valley north of Coushatta. At Coushatta the trench follows to the west of Couchanda Hill, then stays approximately in the center of the valley until it reaches Montgomery. Here it swings to the west of a buried high and makes a broad arc coincident with the arc as seen in the present valley. It follows a central course through the gap in the Catahoula sandstone at Colfax and continues near the center for the rest of its course to its junction with the entrenched valley of the Mississippi River near Palmetto.

Terrace Remnants in the Entrenched Valley

45. It is not the purpose of this discussion to describe the various terrace remnant features which border and possibly underlie the entrenched valley. The stratigraphic column of table 1 lists the names of the four terraces and plates 2, 3, 4, and 5 show the Pleistocene deposits as they have been mapped along the valley wall. That there

are remnants of Pleistocene materials in the trench is hardly to be doubted. In the extreme northern portion of the valley transvalley profile D-D' (plate 9) indicates the possibility of a fairly large remnant of terrace material along the western valley wall. In the vicinity of Alexandria, a stiffening resistance of some of the most basal gravels in the trench to boring-bit penetration was considered to be indicative of an older, firmer terrace remnant. The fill in the trench as far south as Montgomery proved to be almost exclusively red in color from top to bottom. The project borings running through Alexandria, however, encountered some gray materials in the sand and gravel above the Tertiary (see transvalley profile E-E', plate 10). It was anticipated that one of the criteria for distinguishing between Recent and Pleistocene remnants would be a gray color of Recent gravels and an oxidization and consequent red discoloration of underlying Pleistocene remnants. It is probable that this criterion would prove diagnostic in the southern end of the valley. Where there is a repetition of the alluvial sequence, such as clay, sand, coarse sand, then clay, sand and gravel, the inference of Recent over Pleistocene is conclusive. Where the finer grained portions of the Pleistocene sequence have been removed, however, and Recent gravels lie on Pleistocene gravels, the break must be detected by a possible change in color or a change in rate of bit penetration. Several of the project borings encountered materials considered definite remnants of Pleistocene in the trench. Project boring No. 36 is reproduced to show this break (see transvalley profile C-C', plate 8).

Recent

0.0 -	2.0	red brown sandy clay
2.0 -	6.0	red brown sandy silt
6.0 -	34.0	tan silty sand
34.0 -	42.0	tan sand

Pleistocene

42.0 -	97.3	heavy brown clay with gray and brown concretions -- limonitic and calcareous
97.3 -	125.6	gray-brown, sandy clay
125.6 -	126.4	fat brown clay
126.4 -	143.8	medium to coarse gray sand
143.8 -	154.6	coarse gray sand and pea gravel

Miocene

154.6 -	160.0	gray silty clay
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The Pleistocene "Islands" Area

46. Plate 2 shows the direction and shape of the entrenched valley in the Bunkie area. Here the present Red River leaves its old entrenched valley through a gap in the Avoyelles Hills and flows eastward across the alluvial plain of the Mississippi. The entrenched valley continues southward past Evergreen Hills and Gum Ridge, the two Pleistocene "Islands" which form the line of low hills marking the divide between the Mississippi entrenched valley to the east and the Red River entrenched valley. Contours of the Mississippi trench are shown as dotted lines on plate 2.

47. The gap through the Avoyelles Hills followed by the present Red River is a rather deep trench filled with a gray sequence of sediments over which a thin veneer of Red River alluvium has been deposited. The Arkansas River is considered to have cut this trench and formerly entered the Red River Valley north of Bunkie. The gray sediments

represent alluviation by the Arkansas; the red materials forming the present surface were laid down after a very recent shifting of the Red River through the Avoyelles Hills. The scarcity of good borings in this area makes accurate conclusions concerning the depth and origin of this gap impossible.

PART V: SOURCES OF DATA AND BORING METHODS

48. Fisk (14) in a report prepared for the Mississippi River Commission contoured the base of the gravels in the Mississippi River trench using about 1,600 points. These points were taken from various sources including about 300 borings made especially for the project by the Corps of Engineers.

49. Following a similar method of approach, plates 2-5 were prepared for the specific purpose of contouring the base of the gravels in the Red River, or more exactly, to contour the Recent entrenched valley of the Red River.

Sources of Information Other Than Project Borings

50. Logs of approximately 2,000 borings made in the Lower Red River Valley, together with maps and written material from published and unpublished sources, were gathered from government agencies, oil companies, water well drillers and individuals. The following list includes most of these sources of information:

Office of the President, Mississippi River Commission,
Vicksburg, Mississippi
Corps of Engineers, New Orleans District
Corps of Engineers, Vicksburg District
Production Marketing Administration, Alexandria, Louisiana
Production Marketing Administration, Natchitoches, Louisiana
Mr. Paul Jones, U. S. G. S. Groundwater Division, Baton
Rouge, Louisiana
J. Y. Snyder Collection, Louisiana State University, Baton
Rouge, Louisiana
Mr. Leo Hough, Louisiana Geological Survey, Baton Rouge,
Louisiana
Louisiana State Highway Department, Baton Rouge, Louisiana
Amerada Oil Corp., Eola, Louisiana
Haas Investment Company, Bunkie, Louisiana

Mr. H. X. Bay, Texas Oil Company, New Orleans, Louisiana
 Mr. J. H. Todd, California Company, New Orleans, Louisiana
 Mr. R. J. LeBlanc, Shell Oil Company, Houston, Texas
 Dr. H. N. Fisk, Humble Oil Company, Houston, Texas
 Mr. C. L. Moody, Ohio Oil Company, Shreveport, Louisiana
 Mr. R. T. Wade, Schlumberger Well Surveying Corp., Shreveport,
 Louisiana
 Mr. Justin Rukas, Consulting Geologist, Shreveport, Louisiana
 Mr. W. C. McGee, Tennessee Gas Transmission Company, Houston,
 Texas
 Mr. M. N. Kelly, Gulf Utilities Company, Coushatta, Louisiana
 Mr. H. L. McMullin, Texas and Pacific Railroad, Dallas, Texas
 Mr. L. P. Hogge, Central Louisiana Electric Company,
 Alexandria, Louisiana
 Mr. E. L. Saulsberry, Kansas City Southern L & A Railroad,
 Kansas City, Missouri
 Mr. D. R. Pflug, United Gas Company, Shreveport, Louisiana
 Mr. S. J. Simmons, Water Well Driller, Big Cane, Louisiana
 Mr. F. J. Scoggins, Layne-Louisiana Wells, Monroe, Louisiana
 Mr. J. B. Dyes, Water Well Driller, Shreveport, Louisiana
 Mr. M. C. Forsong, Water Well Driller, Shreveport, Louisiana
 Mr. B. F. Eddington, Acme Water Wells, Shreveport, Louisiana
 Rabon Drilling Company, Shreveport, Louisiana
 Mr. L. P. Blevins, Water Well Driller, Natchitoches,
 Louisiana
 Mr. W. F. Blackman, Alexandria, Louisiana
 Carlross Well Supply Company, Memphis, Tennessee
 Grey Artesian Well Company, Pensacola, Florida
 Mr. F. R. Gibson, Layne-Louisiana Drilling Company, Lake
 Charles, Louisiana
 Mr. S. O. Scoggins, Coastal Water Well Corp., Welsh, Louisiana
 Mr. F. K. McDermott, Water Well Driller, New Roads, Louisiana

Types of Information Other Than Project Borings

51. Logs of water wells were taken from the files of the Ground-water Division of the U. S. Geological Survey at Baton Rouge, Louisiana, and additional water well information was solicited from drillers in the field. Reliability of logs varies with the driller. A number of the logs were obtained orally, with the driller trusting to memory as to the depths at which gravels were encountered and passed through. These logs, coupled with project borings, proved to be one of the best sources of

information.

52. Driller's logs of oil wells, from the files of the Louisiana Geological Survey and the J. Y. Snyder Collection at Louisiana State University furnished a source of information which could be used in some instances. Unfortunately drillers logs since 1920 are usually poor sources for determining the depth of alluvium. They sometimes begin with such bald statements as "0-1220 feet, top soil". Older logs, however, were more carefully kept and thus provide more reliable information.

53. Numerous shallow borings were made in the area under investigation by the New Orleans and Vicksburg Districts, Corps of Engineers. Locations, elevations, and logs are excellent. Unfortunately the great majority of these borings are too shallow for depth-of-gravel determinations.

54. Electrical logs of oil wells and water wells are excellent sources of information. The break between Tertiary and overlying Recent is well marked on both the self-potential and resistivity curves (see figure 4). In the southern portion of the valley where gravel thicknesses are greatest, the marked increase in porosity of the thick graveliferous sections, as contrasted with the tight Fleming clays and silty sands below, is excellently recorded on electric logs. Only few electric logs are available on water wells, and the great majority of logs on oil wells begin at depths which are too great to show the contact. Of particular value were the electric logs of exploratory cores, records of which are not required by the Louisiana Conservation Commission but can often be obtained by contacting individual oil companies.

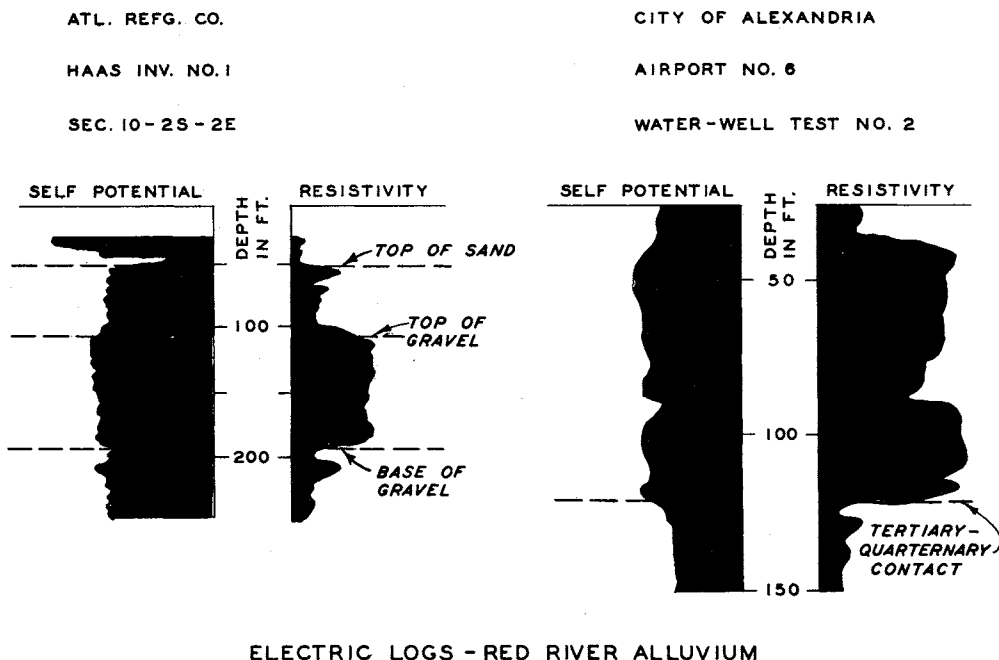


Figure 4

55. Shot point logs give the most complete coverage of individual areas. If reliable logs were kept they would prove of inestimable value, especially in the northern portions of the valley where their shallow depths encounter the Tertiary. Even poorly kept logs, however, usually record the striking change when passing through the gravel into the distinctly different Tertiary below. They were extremely useful as points for contouring, in the northern portion of the valley.

56. Borings made for foundation purposes along Louisiana State Highway bridges and for pipe-line crossings were also used. These were excellent where they penetrated the Tertiary.

Project Borings

57. Fifty-one project borings, using a truck-mounted rotary core drill, were made in the Recent, and one was put down through the

Pleistocene. These borings were spaced with several factors in mind. In order to save expense and time, only transvalley profiles which could utilize existing parish or state highways were plotted. Borings were spaced in such a way as to make the best use of available information and to aid in evaluating indefinite information gathered from other sources. An attempt was made to place the borings where preliminary examination of aerial photographs indicated differences in environment of alluvial deposition. In the field, permission was given the drillers to change the position of an individual hole 1,000 ft in any direction from a plotted point in order to take advantage of a nearby water supply. In most instances the driller located holes as plotted.

58. A three-man crew was used for the first several weeks; one man, an inspector, kept the log and collected and labeled the samples, while the other two operated the rig. An auger was used for the first 10 ft of the hole, and ordinarily one sample was collected from each 3-ft plunge of the auger, or wherever a break in lithology occurred. A fishtail bit, boring a hole approximately 4 in. in diameter, was used for the remainder of the hole. A disturbed core (sometimes undisturbed) was taken at the Tertiary contact. When the writer was in the field, cores were taken whenever they might prove significant, sometimes as many as four being taken in one hole.

59. Cores were made with a "poor-boy" bit which is ordinary 2-in. drill pipe with teeth cut on one end and hard-surfaced. In many instances it was found possible to use the "poor-boy" exclusively, without use of the fishtail. This saved considerable time when samples were needed. All it necessitated was shutting off the water supply and

slowly turning the bit while pushing it into the section to be cored. This ordinarily resulted in disturbed cores. The Tertiary, however, was firm enough to sometimes provide an undisturbed sample.

60. Logs of the 51 project borings are available in the files of the Waterways Experiment Station, as well as the logs of various water wells and other data sources used in contouring the entrenched valley. Logs of project borings were used to evaluate the data which had been collected. Obviously unreliable logs were discarded and only those which were considered fairly reliable were used for contouring. The remaining logs were evaluated, and divided into good logs and poor logs depending on such factors as poor location, oral communication, and many other limitations. The poor logs are shown as circles on the plates. Those logs considered good are shown as filled-in circles.

PART VI: SUMMARY

61. Considerable information has been gathered during the past decade on the entrenched valleys of the rivers of the Gulf Coastal Plain. Prior to the turn of the century, the existence of such subsurface trenches had been indicated by scattered borings in the Mississippi River Valley, but little work had been done to delineate the extent of the trenches or hypothesize their origin. Fisk's (14) work for the Mississippi River Commission was the first such inclusive work and subsequent reports on the trenches of the Mermentau (33) and Calcasieu (3) Rivers all showed analogous erosional cuts, sloping seaward at a fairly rapid rate and filled with a sequence of Recent sediments which graded from coarse gravel at the base, through sand, and into finer material at the top.

62. The natural agency to which these trenches has been attributed is glaciation; not, of course, to the ice masses themselves, but to the effect which this volume of land-locked water had on sea level. During glacial stages sea level fell, greatly steepening the gradient of the streams and cutting the entrenched valleys. During the interglacial stages, rising sea level caused the filling of these trenches. The present valley fills each exhibit an almost unvarying sequence of coarse to fine sedimentation.

63. Downcutting of the Mississippi steepened the gradients of its tributary streams and forced them to degrade their valleys. The entrenched system of the Red River exhibits a striking steepness of gradient near Palmetto, Louisiana, where it enters the entrenched

valley of the Mississippi. Depths of alluvium in the trench vary from 60 ft in the northern end of the area under study to nearly 300 ft near the confluence of the two trenches. As a rule the shape of the valley is steep-sided with a shelf-like floor sloping gently to the deepest part of the trench. The deepest portion is usually accentuated by a small, steepened V which marks the position of flow of the ancient degrading channel.

64. The floor of the entrenched valley is highly irregular, with buried ridges dividing the minor drainage into the entrenched Red. Local highs occur within the valley and in several instances reach the surface and are preserved as "islands" which are now surrounded by Recent sediments. The sediments which comprise the floor of the valley are in every instance of a firmer and more erosion-resistant nature than the overlying clays, silts, sands, and gravels of the Recent. These older sediments are Tertiary in age and range from hard, extremely durable sandstone to relatively easily erodible silt, sand, and clay. In every instance, however, they are firmer than the Recent sediments. Their vastly greater age, greater compaction, and locally well-indurated nature have influenced the shape of the valley, and where the present Red River impinges against them in the valley walls, or scours into them along its present course, their effect on river activity is notable.

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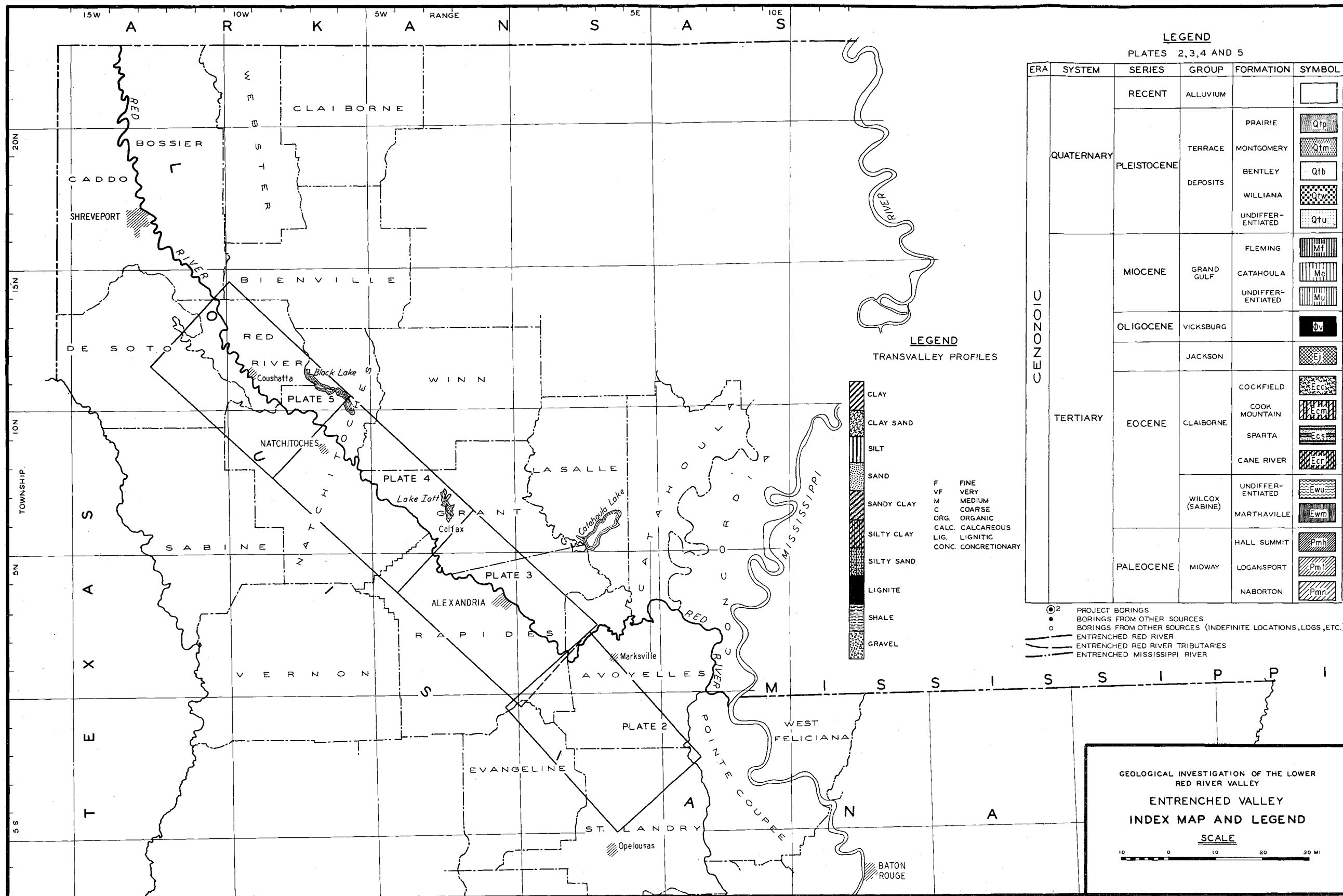
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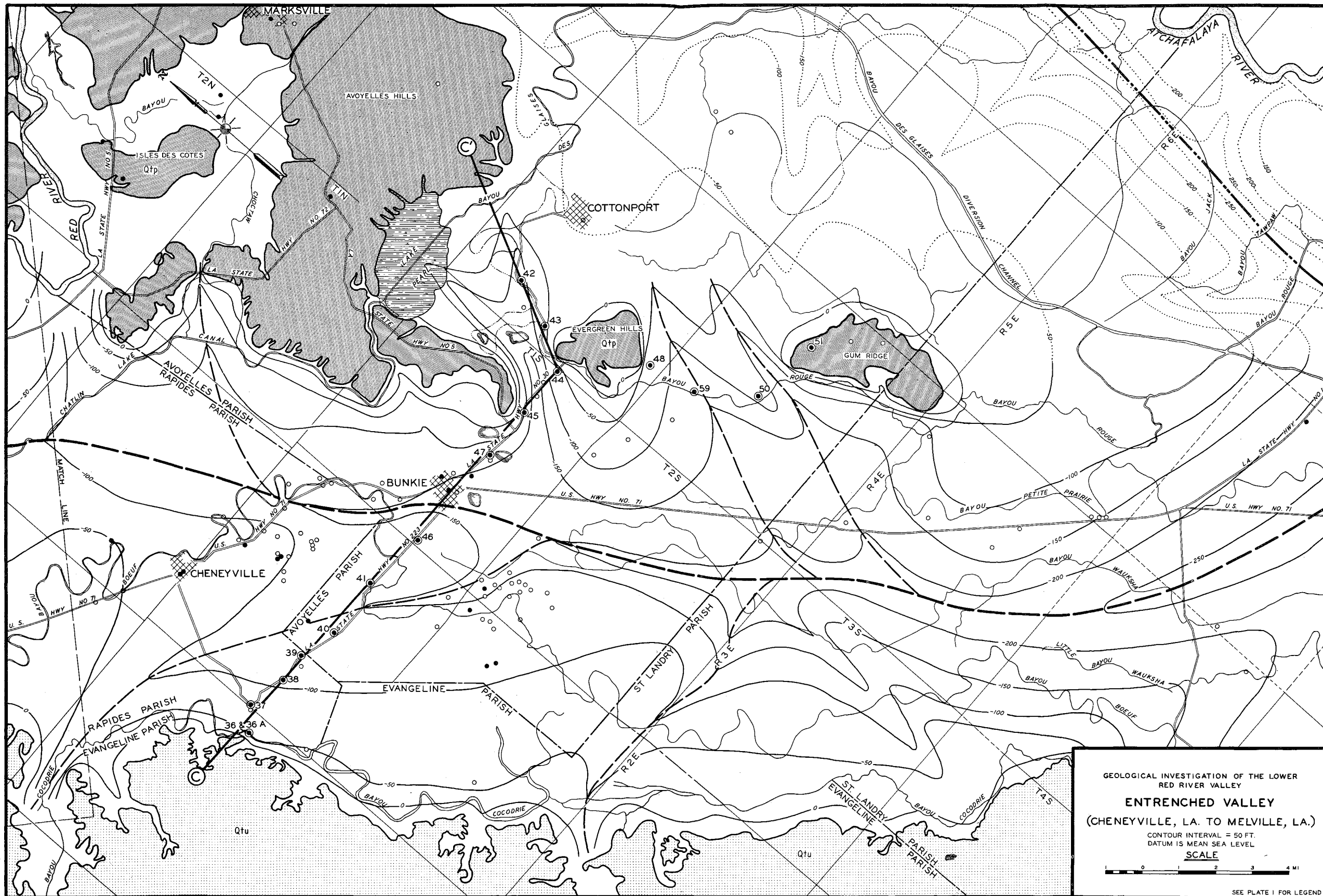
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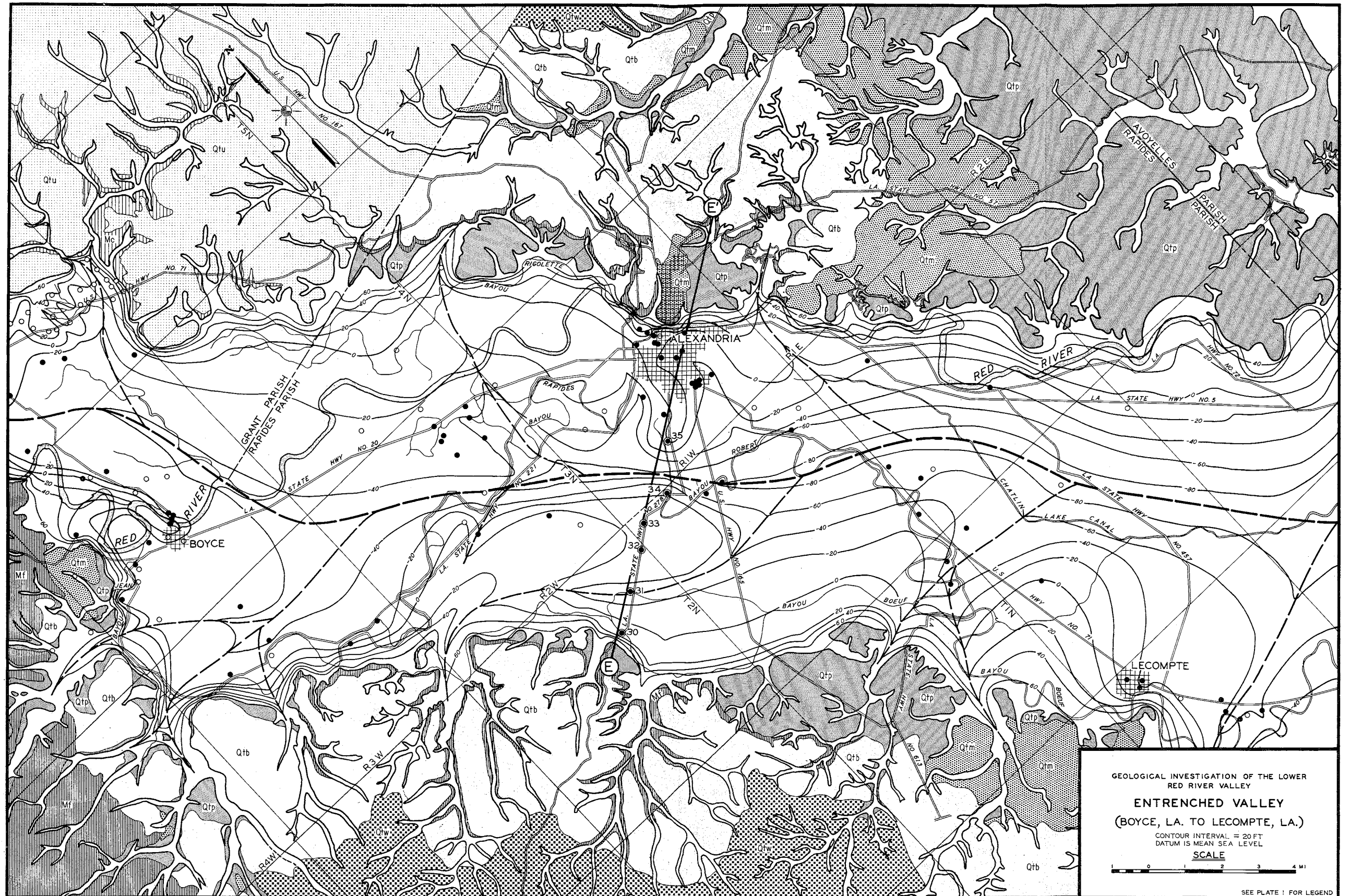
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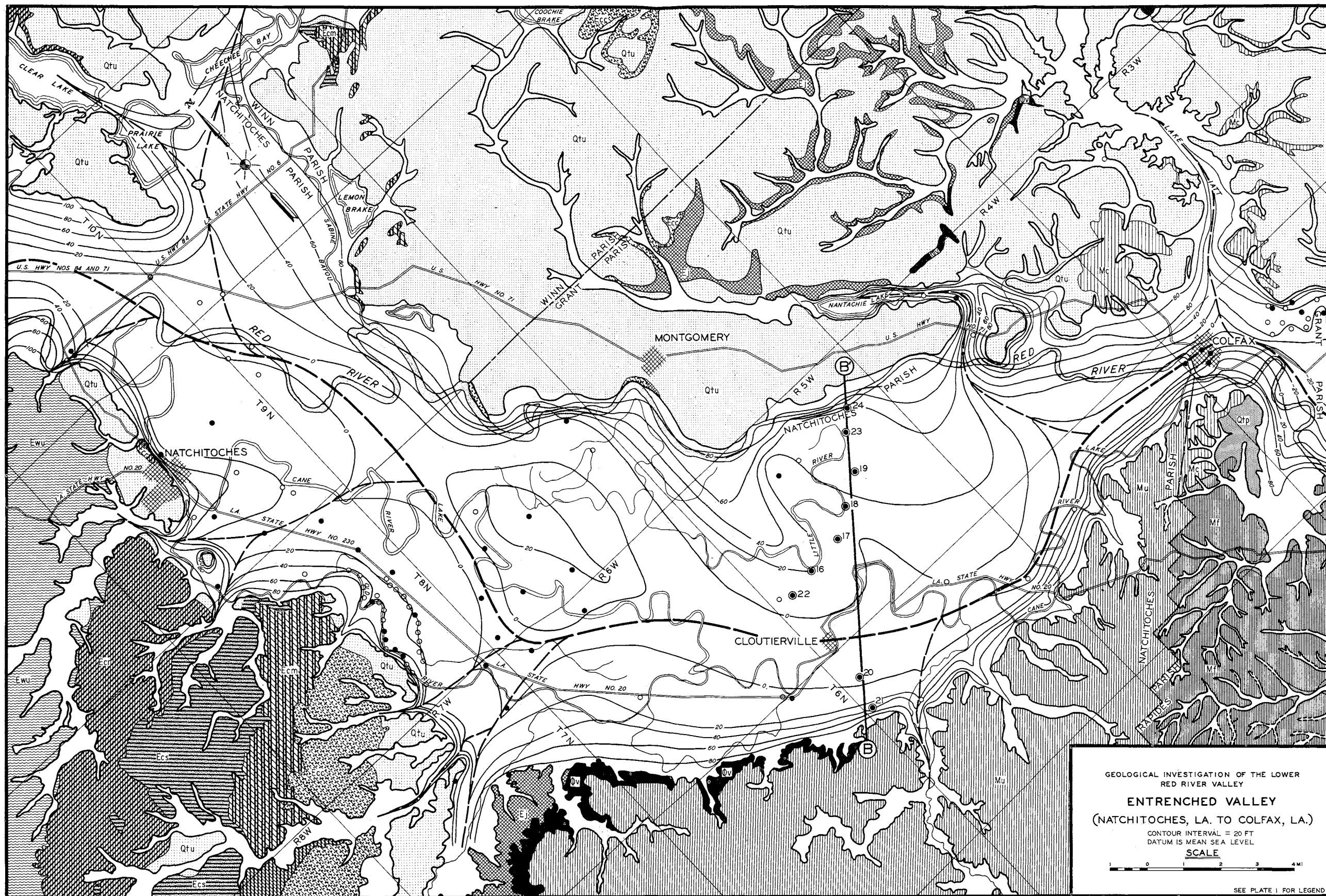
PLATES

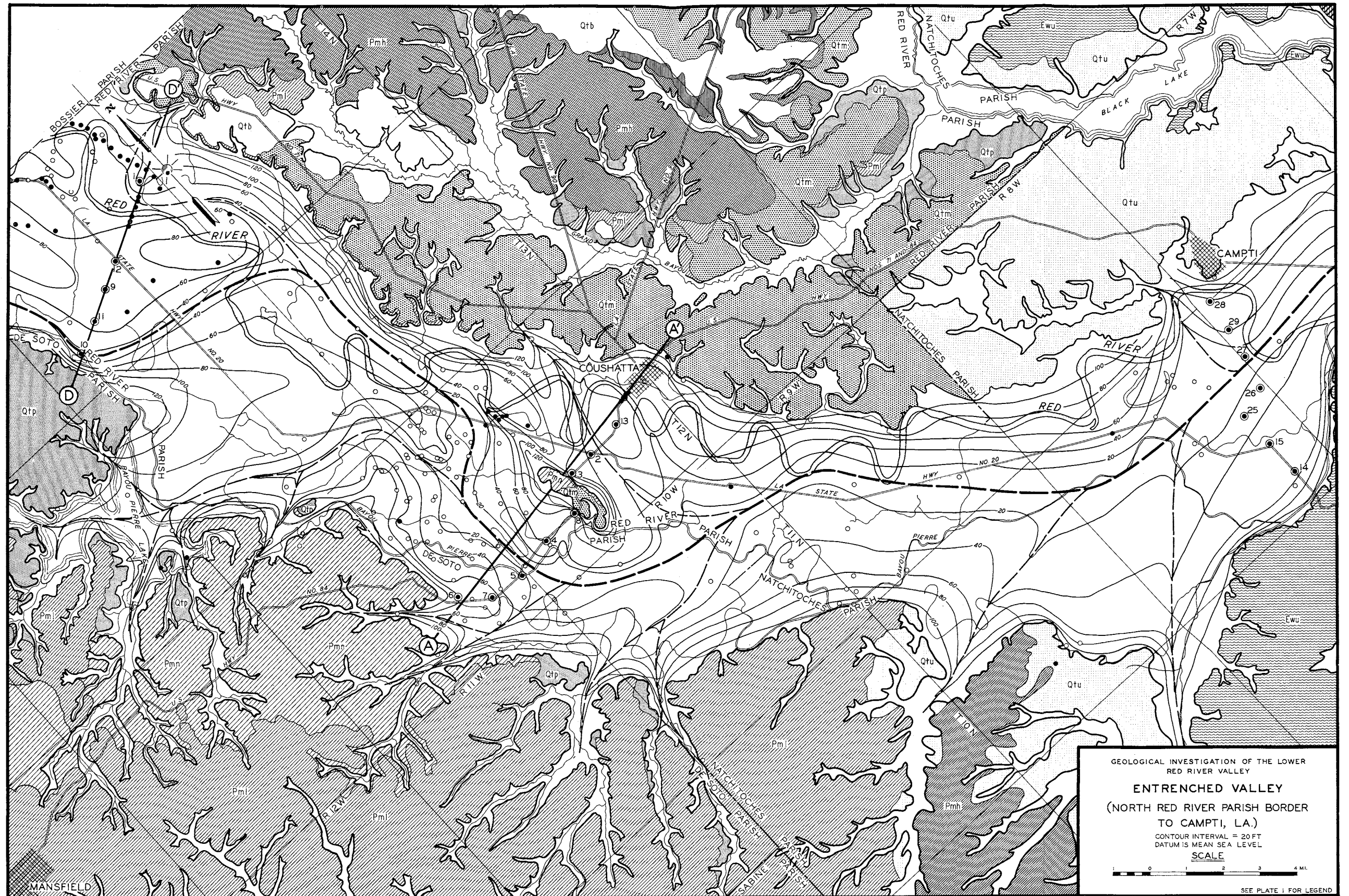




GEOLOGICAL INVESTIGATION OF THE LOWER
RED RIVER VALLEY
ENTRENCHED VALLEY
(CHENEYVILLE, LA. TO MELVILLE, LA.)
CONTOUR INTERVAL = 50 FT.
DATUM IS MEAN SEA LEVEL
SCALE
0 1 2 3 4 MI
SEE PLATE I FOR LEGEND







GEOLOGICAL INVESTIGATION OF THE LOWER
RED RIVER VALLEY

ENTRENCHED VALLEY
(NORTH RED RIVER PARISH BORDER
TO CAMPTI, LA.)

CONTOUR INTERVAL = 20 FT
DATUM IS MEAN SEA LEVEL

SCALE



SEE PLATE 1 FOR LEGEND

